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ACCIDENT EXPERIENCE AND COST IN WYOMING COAL MINES

BY

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By D. J. Parker[2]

INTRODUCTION

Before the various States began to enact workmen's compensation laws accidents were considered inherent in many industries, and little or no effort was made to prevent or reduce them. The hazard was accepted by the employee with the job, and the avoidance of accidents by mental alertness or physical agility was largely his responsibility. After the employee had given evidence of enough skill in performing his allotted task efficiently the responsibility of the employer apparently ceased with respect to the personal safety of the employee.

However, following the enactment of workmen's compensation laws, at least two facts that had not before been fully appreciated soon became apparent: (1) The majority of accidents can be prevented if the management firmly determines to prevent them; (2) from a monetary point of view alone accidents are decidedly expensive, both to employer and to employee. It is now evident that savings effected by conscientious safety effort add substantially to net profits of operation.

During the last few years industry has realized as never before that the attitude of the public can no longer be ignored in relation to accidents. There is no surer way to crystalize public sentiment in favor of an industry than by an effective, sincere, and honest program for the prevention of accidents, and public sentiment toward an industry or an individual unit of such industry often means success or failure for that particular industry or unit.

Unquestionably the coal-mining industry has suffered in the past from criticism, some of it unjust but largely deserved, as a result of its high accident rates. During the last 2 years, however, the improvement in reduction of accidents has been marked, the best record in the entire history of the industry.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6791."

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In the early days when satisfactory settlement was not possible following an injury in coal mines litigation was the last resort, and many personal-injury cases were presented before the courts. Because the best legal talent was usually employed by the defendant, the plaintiff or injured workman almost invariably lost the suit, though the cost to the victor was by no means negligible. Even when the plaintiff was successful in his initial effort usually his resources were exhausted long before final decision was handed down by the courts, and the amount received by the successful plaintiff was but a small proportion of the total cost to the defendant. Compensation laws have therefore been a blessing to employer and employee alike. The employer has found it less expensive to make direct payments under schedules of compensation laws for accidents, but of far more importance he has found it much less costly to prevent accidents than to pay for them. The employee is afforded a means of living while incapacitated, or in the event of fatal injury dependents are at least temporarily provided with the necessities of life. The employer has also found that with the exercise of readily available precautions accident occurrence can be greatly curtailed if not entirely eliminated.

ACKNOWLEDGMENT

The writer expresses his sincere appreciation to the several companies who so generously cooperated in furnishing the data on which this paper is based.

WORKMEN'S COMPENSATION ACT OF WYOMING

The Wyoming Workmen's Compensation Act and Acts Relating Thereto, with amendments to May 1, 1933, is rather broad in scope; it covers almost every form of occupation, except as herein noted, with no restrictions on the minimum number employed by any one company or concern. The act does not apply to employees engaged in interstate commerce, domestic service, ranching, farming, agriculture, horticulture, or stock raising or to any person holding an appointment as sheriff, deputy sheriff, constable, or deputy constable. All other occupations, including mining and "dude ranching", are classed as "extra hazardous" and fall within the scope of the act.

No compensation for temporary total disability except the expense of medical attention is allowed for the first 7 days of disability unless the incapacity extends beyond the period of 21 days, in which case the compensation runs from the time of the injury. If unmarried the injured workman receives $50 per month; if married he receives not to exceed $90 per month, the amount awarded varying with the number of dependents.

In all cases of temporary total disability, permanent partial disability, and permanent total disability the expenses of medical attention and hospital care of the injured are paid from date of injury, the expense of medical treatment not to exceed $150 in any case and the hospital expenses not to exceed a like sum unless under general arrangement the workman is entitled to medical attention and hospital care or the employer furnishes adequate and proper medical attention and hospital facilities to his employees.

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If death results from an injury the expense of burial is paid, not to exceed $150 in any case unless other arrangements have been made between employer and employee.

SCHEDULE OF COMPENSATION

Compensation for permanent partial disability is expressed in terms of money and not on the basis of days lost, either actual or theoretical. For any permanent partial disability resulting from an injury the workman receives a lump sum as set forth in table 1. Injuries due to "culpable negligence" on the part of the injured are not compensable.

TABLE 1. - Wyoming compensation schedule

Disability	Compensation
Loss of a thumb	$ 337.50
Loss of a first finger	300.00
Loss of a second finger	225.00
Loss of a third finger	225.00
Loss of a fourth finger	225.00
Loss of a palm (metacarpal bone)	900.00
Loss of a hand	1,500.00
Loss of an arm at or below elbow	1,800.00
Loss of an arm above elbow	2,000.00
Loss of a great toe	200.00
Loss of one of the toes other than great toe	150.00
Loss of a foot	1,200.00
Loss of a leg below the knee	1,800.00
Loss of an eye or the sight thereof	1,800.00

For permanent total disability $4,000 is paid on a monthly basis, and in case of death $2,000 is allowed, also paid on a monthly basis.

Table 2 gives the lost days charged for permanent injuries. This weighting is used by the United States Bureau of Mines, the National Safety Council, and many operators in determining and comparing the severity of accidents. By such standardization of weighting the severity of accidents is placed on a

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comparable basis. If a weighting system were adopted by the operators of the various coal-producing States it would be decidedly advantageous in determining the actual progress being made in accident prevention work.

TABLE 2. - Scale of time losses for weighting industrial accident disabilities to show severity of accidents, National Safety Competition basis

Nature of injury	Degree of disability in percentage of permanent total disability	Days lost
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment	75	4,500
Arm at or below elbow, dismemberment	60	3,600
Hand, dismemberment	50	3,000
Thumb, permanent disability	10	600
Any one finger, permanent disability	5	300
Two fingers, permanent disability	12½	750
Three fingers, permanent disability	20	1,200
Four fingers, permanent disability	30	1,800
Thumb and one finger, permanent disability	20	1,200
Thumb and two fingers, permanent disability	25	1,500
Thumb and three fingers, permanent disability	33 1/3	2,000
Thumb and four fingers, permanent disability	40	2,400
Leg above knee, dismemberment	75	4,500
Leg at or below knee, dismemberment	50	3,000
Foot, dismemberment	40	2,400
Great toe or any two or more toes, permanent disability	5	300
One toe other than great toe, permanent disability	0	.....
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

WYOMING ACCIDENT EXPERIENCE

Table 3 shows the ratio of fatalities to coal produced and to man-days worked for all Wyoming coal mines from 1927 to 1932, inclusive. During this 6-year period Wyoming produced 35,231,066 tons of coal, with 111 underground and surface fatalities. The fatality rate per million tons produced was 3.12, which compares favorably with the 1932 record of 3.31 for the entire country. The 1932 rate is one of the lowest fatality rates in the history of coal mining in the United States.

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TABLE 3. - Ratio of fatalities to production and man-days worked in all Wyoming coal mines, 1927-32, inclusive, according to the State Department of Mines

Year	Mines operating	Coal produced, tons	Average days active	Total employed	Man-days worked	Fatal accidents	Tons per fatality	Man-days per fatality	Fatalities per million tons mined
1927	62	6,738.561	176	5,639	992,464	22	306,298	45,112	3.26
1928	58	6,553,174	216	4,768	1,029,888	25	262,127	41,195	3.81
1929	62	6,699,779	213.5	5,081	1,084,793	21	319,037	51,657	3.13
1930	69	6,070,769	185	4,368	890,844	23	263,946	38,732	3.78
1931	85	5,000,365	154.6	4,675	722,755	14	357,168	51,625	2.80
1932	92	4,168,418	150.2	4,236	636,247	6	694,736	106,041	1.43
Total or averages		35,231,066	182.2	29,267	5,356,991	111	317,397	48,261	3.12

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During this period Wyoming mines produced 317,397 tons of coal and worked 48,261 man-days for each fatality. In 1932 there were only 6 fatalities, compared with 14 in 1931, the next best year. The highest number of fatalities (25) during the 6-year period occurred in 1928. The fatality rate per million tons mined for 1932 was 1.43, considerably less than half the rate for the entire country for 1932.

ACCIDENTS IN 27 REPRESENTATIVE MINES

For convenience and to avoid disclosing the identity of individual mines or mining companies the 27 mines have been divided into 9 groups, each designated by letter. These mines represent 37 percent of the average of all mines operating over the 6-year period, and the total tonnage of the 9 groups is 57 percent of the total tonnage produced by the State for the same period. All except 5 of the 27 mines operated for the full 6-year period.

In group A 1 mine operated for less than 2 years and another for only 5 months; the other mines of this group operated for the full 6-year period. In group D 2 mines operated for less than 6 years, 1 for 3 years and 7 months, and 1 for 5 months. In group I 1 mine operated for only 2 years, the only one operating less than 6 years.

During the period covered by this report the total tonnage produced was 20,457,332, with 1,779 accidents resulting in 69,418 actual days lost.

PRODUCTION AND ACCIDENTS

Table 4 gives production and accident data for 27 Wyoming coal mines.

The total of 1,779 accidents includes 54 fatalities, 3 total permanent disabilities, 117 partial permanent disabilities, and 1,605 other lost-time accidents.

The "total accidents" column includes all accidents causing the loss of one or more days other than that on which the accident occurred. The average number of accidents per year was 296.5.

Table 4 gives an accurate picture over a 6-year period but does not indicate the progress made in reducing accidents, especially fatalities. For example, in the last 5 groups (E to I, inclusive) there was only 1 fatal accident in 1932, compared with 12 in 1929. Group C, relatively small operations, had no fatal accident during the 6-year period. Group D also had no fatal accident in 1932, compared with 3 in 1927, and only 1 for each of the other 4 years.

ACCIDENT FREQUENCY AND SEVERITY

Table 5 shows accident frequency and severity rates for each group of mines - actual days lost and also days lost according to the schedule of weighing accidents, fatal as well as nonfatal, used in the National Safety Competition conducted annually by the United States Bureau of Mines.

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TABLE 4. - Production and accidents in 27 Wyoming coal mines, 1927-32, inclusive.

Group	Total coal produced, tons	Years active	Average employed	Total man-days worked	Total accidents Total	Days lost[1]
A	2,193,498	5 months to 6 years	332.6	386,020	314	11,009
B	984,244	6	137.3	131,553	109	1,810
C	431,465	6	24.6	48,267	17	563
D	1,552,507	5 months to 6 years	131.6	354,037	137	6,003
E	4,731,628	6	225.5	649,487	385	16,146
F	1,758,754	6	184	238,128	142	7,728
G	2,359,525	6	210	315,296	202	8,479
H	3,586,385	6	122.6	439,263	235	12,846
I	2,859,326	2 to 6	66.6	263,827	188	4,829
Total	20,457,332				1779	69,418

[1] Contains no charge for fatal or total disability accidents.

TABLE 5. - Accident frequency and severity rates in 27 Wyoming coal mines 1927-32, inclusive.

Group	Fatal-ities	Total permanent disabilities	Partial permanent disabilities	Other Lost-time accidents	Days lost, Wyoming basis	Days lost, National competition basis	Total man-hours worked	Frequency rate	Severity rate
A	7	1	16	290	11,009	59,009	3,088,160	101.67	19.11
B	5	1	9	94	1,810	37,810	1,049,244	103.88	36.03
C	0	0	1	16	568	568	386,136	44.02	1.47
D	7	0	6	124	6,003	48,003	2,832,296	48.37	16.94
E	10	1	21	353	16,146	82,146	5,195,896	74.09	15.81
F	2	0	9	131	7,728	19,728	1,905,024	74.53	10.35
G	6	0	22	174	8,479	44,479	2,522,368	80.08	17.63
H	9	0	26	250	12,846	66,846	3,919,144	72.71	17.05
I	8	0	7	173	4,829	52,829	2,110,616	89.07	25.03

The frequency rate is the ratio of the number of accidents per million man-hours worked and is found thus:

$$\frac{\text{Number of accidents} \times 1,000,000}{\text{Man-hours worked}} = \text{frequency rate.}$$

The severity rate is the ratio of the days lost per 1,000 man-hours worked and is found as follows:

$$\frac{\text{Days lost} \times 1,000}{\text{Man-hours worked}} = \text{severity rate.}$$

The severity rate in table 5 is calculated on the theoretical number of days lost as set forth in the column headed, "Days lost, National Competition basis." The severity rate based on days lost, Wyoming basis, obviously would be much lower.

Because group C had no fatal or permanent disability accident during the 6-year period, it had the lowest severity rate (1.47); group B had the highest severity rate (36.03) of the nine groups. Group C had the lowest frequency rate (44.02) and group B, the highest (103.88). Group B had the highest frequency and severity rates of the nine groups, possibly because of adverse natural conditions or laxity in supervision.

Attention is directed to the fact that during the 6-year period 1927-32, inclusive, only three total permanent disability accidents occurred.

CAUSES OF ACCIDENTS

Table 6 classifies the accidents that occurred during the 6-year period according to nature and cause, with segregation of surface and underground accidents.

Thirty-three of the 54 fatalities were caused by falls of roof or coal and 11 by haulage; the latter is surpassed only by falls of roof or coal as a cause of accidents, although responsible for almost as many partial disability and other lost-time accidents. Only one fatality occurred on the surface, and this was due to electricity. Flying rock or coal was responsible for 1 fatality and 97 lost-time accidents.

Underground machinery other than mining machines caused 1 fatality and 122 lost-time accidents. Most of the mines are highly mechanized; mechanization probably accounts for the large number of lost-time accidents. Handling of material underground was responsible for 110 lost-time accidents and falls of persons underground, 121 accidents; the latter may indicate poor illumination, defective vision, or poor "housekeeping", coupled with inadequate supervision.

Handling material, machinery, miscellaneous causes, falls of persons, and haulage ranked in the order given as causes of accidents. An analysis of table 6 clearly indicates the points of greatest hazard and the necessity for increased supervision and education.

TABLE 6. - Causes of accidents in 27 Wyoming coal mines, 1927-32, inclusive.

Cause	Fatalities	Total disabilities	Partial disabilities	Other lost-time accidents	Total lost-time accidents
Underground:					
Falls of roof or coal	33	3	28	384	448
Flying coal or rock	1	0	14	82	97
Haulage	11	0	26	351	388
Electricity	1	0	4	26	31
Mining Machines	1	0	8	42	51
Gas Ignitions	1	0	3	2	6
Machinery	1	0	5	116	122
Explosives	2	0	0	5	7
Handling Material	0	0	7	103	110
Tools	0	0	5	83	88
Falls of person	0	0	2	119	121
Nails	0	0	0	5	5
Miscellaneous	2	0	2	149	153
Surface:					
Haulage	0	0	0	21	21
Railroad Cars	0	0	0	6	6
Machinery	0	0	4	19	23
Handling Materials	0	0	3	29	32
Falls of person	0	0	4	22	26
Tools	0	0	0	13	13
Electricity	1	0	1	2	4
Miscellaneous	0	0	1	26	27

TABLE 7. - Accident cost at 27 Wyoming coal mines, 1927-32, inclusive

Group	Coal produced, tons	Cost of medical-hospital administration	Compensation awarded	Total direct cost	Direct cost per ton, cents
A	2,193,498	$ 10,967.49	$ 46,280.25	$ 57,247.74	2.61
B	984,244	31,649.00	32,640.00	64,289.00	6.53
C	481,465	2,407.33	1,278.72	3,686.05	.76
D	1,552,507	2,619.96	28,081.65	30,701.61	1.97
E	4,731,628	23,658.24	76,231.57	99,889.81	2.11
F	1,758.754	8,793.77	25,637,77	34,431.54	1.95
G	2,309.525	11,547.63	44,617.52	56,165.15	2.43
H	3,586,385	17,931.93	59,826.72	77,758.65	2.16
I	2,859.326	14,296.63	48,201.25	62,497.88	2.18

COST OF ACCIDENTS

In an effort to determine the monetary cost of accidents it is generally assumed that such expense is divided into two classes, direct and indirect. In the final analysis, however, loss of life, or total disability and the suffering due to accidents cannot be evaluated in terms of money. Direct cost covers compensation paid to injured workmen, medical attention, and hospitalization; indirect or hidden cost, with which industry is not particularly familiar, includes loss of wages to the injured not covered by compensation, time lost by other employees, damage to equipment, loss of production, overhead expense, lowering of morale, and temporary demoralization as well as numerous others. An eminent authority on accident prevention work has estimated that the indirect or hidden cost is at least four times that of the direct cost.

Table 7 gives for the 9 groups of mines the cost per ton on a total direct-cost basis, which ranges from 0.76 to 6.53 cents per ton and averages 2.37 cents.

Five of the nine groups charge 1/2 cent per ton for "medical-hospital administration"; the actual figures are available for 2 other groups. The charge for the 2 remaining groups, for which accurate data on medical and hospitalization costs were not available, was arbitrarily assumed to be the same as used by the five groups, 1/2 cent per ton. This figure, although manifestly not accurate for these two groups, is believed to be close enough to complete the picture without vitiating to any considerable extent the accuracy of the data.

The total direct accident cost for the 6-year period for all groups was $486,667.43. If the ratio of direct to indirect cost is assumed to be 1:4, the grand-total cost of accidents in the 27 mines would be $2,433,337.15, or 11.89 cents per ton. While this is excessively high it should be remembered that accidents cost much more than money; hence prevention of accidents is very much worth while and certainly cannot be considered useless.

SUMMARY

Table 8 summarizes the accident experience of all groups combined. It is believed that this record will compare favorably with that of many of the coal-producing States in the United States and perhaps is equal to or better than that of most of the Western States. As might be expected, some of the mines covered by the nine groups had much better accident records than others. Combining the statistics for all groups, as in table 8, gives a comprehensive picture of the situation for these properties scattered through the entire State.

Although it is recognized that substantial progress is being made in the prevention of accidents in the coal mines of Wyoming, obviously from this record there is much room for improvement. As evidence of progress, one company with unusual enterprise, energy, and persistence had the eyes of every workman examined and quartz glass goggles ground to prescription for each individual; the cost of examination and goggles was borne entirely by the company. As a result of the enforcement of an inflexible rule, goggles are worn by all employees, and there has not been an eye injury underground or on the surface since April 1933.

Another concrete example of progress is the offer by one company (whose experience is included in this paper) of substantial rewards for meritorious accident records in which the workmen as well as the foremen have an opportunity to participate. Largely through such means this company now enjoys the lowest accident experience in its entire history.

Doubtless many good accident records are achieved without a bonus or other special recognition, but it would appear that some added incentive over and above the daily wage is likely to give increased stimulus to greater safety, with resultant numerous benefits to both employer and employee.

TABLE 8. - Summary of accident data for 27 Wyoming coal mines, 1927-32, inclusive.

Number of mines	27
Coal produced . . . tons	20,457,332
Man-days worked	2,875,883
Fatal accidents	54
Total permanent disabilities	3
Partial permanent disabilities	117
Temporary disabilities	1,605
Total lost-time accidents	1,779
Total time lost (National Competition basis) days	411,418
Time lost per accident . . . do	231.12
Accidents per fatality	32.9
Coal produced per accident . . . tons	11,505.8
Coal produced per day lost . . . do	49.7
Direct accident cost . . . cents per ton	2.37
Frequency . . . rate	77.31
Severity . . . do	17.88

It is confidently believed that with unremitting effort, effective inspection, close supervision, rigid discipline, and safety education of the workers accidents can be greatly reduced in the coal mines of Wyoming. However, such reduction cannot be expected unless the management firmly determines to prevent accidents; at the same time the supervisory force, including the management, must assume most of the responsibility for accidents, with the idea of ultimately transferring as much as possible of the burden back to the workers by education or other methods of obtaining their cooperation in the avoidance of accidents.